CDR-915 Data Radio Module
INTEGRATOR'S GUIDE

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CDR-915 Data Radio

General Information and Labeling Requirements

This CDR-915 is a frequency-hopping spread spectrum data transceiver operating in the 902-928 MHz ISM band. The unit is designed to operate under Part 15.247 of the FCC rules and regulations and is designed as an OEM module for integration into other products or field devices. When installed using an approved antenna, the user need only ensure that the appropriate FCC information is clearly visible on the outside of the integrated product. This label should contain one of the following phrases to be considered valid.

1. **"Contains Transmitter Module FCC ID: PHO-CDR915X" or**
2. **"Contains FCC ID: PHO-CDR915X**

For integration into products sold in Canada, the label should read as follows.

Contains Transmitter Module IC: 4315A-CDR915X

The term "IC:" before the certification/registration number only signifies that the Industry Canada technical specifications were met.

Caution: *If this radio is integrated into another product, the user is responsible for complying with the external labeling requirements as directed in the FCC Rules and Regulations Part 15.19. To avoid the need to obtain additional certification, the user should only use antennas that have been tested and approved for use with this radio.*

The unit operates on 25 discrete frequencies within the ISM band, each frequency about 800 kHz apart. Using a frequency agile phase-locked loop synthesizer, the radio is able to scan all 25 channels and quickly acquire synchronization with a transmitting radio.

The radio is connected to a host device using a 10-pin SIP header. This connection provides the radio with the required DC power source, allows it to be programmed and configured and provides all I/O lines for both an asynchronous serial as well as an SPI interface.

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CDR-915 DATA RADIO
REGULATORY

FCC RF Exposure Statement

This device complies with FCC radiation exposure limits as set forth for an uncontrolled environment.

This device should be installed and operated with a minimum separation distance of 20 cm between the radiator and your body.

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CDR-915 DATA RADIO
CONFIGURATION

Default Settings

Serial Baud...9600 bits/second

Port .... UART

RX buffer size .... 190 bytes*

TX buffer size .... 190 bytes*

CTS assert ....89 bytes

CTS de-assert.. 178 bytes

Packet size.. 177 bytes

Preamble bytes... 266 bytes

TX assert .... 177 bytes/5 mS

Ack-Back™ retries...15

Ack-Back™ timeout.. 200 mS

Channel 1

Source Address... 1

Destination Group.. 1

Destination Address 1

Ack-Back™ mode...Off

*Factory setting; cannot be changed.

CDR-915 DATA RADIO
CONFIGURATION

The CDR-915 is supplied with an easy-to-use Windows98™ configuration program. The configuration program allows the user to control the operation of their radio network.

Installing

The configuration software does not require an installation. Simply run it from the CD labeled "CDR-915 Tools" or copy it onto another drive. Start the program by locating and double-clicking on the "Programmer" icon. This will launch the configuration program and display the screen below.
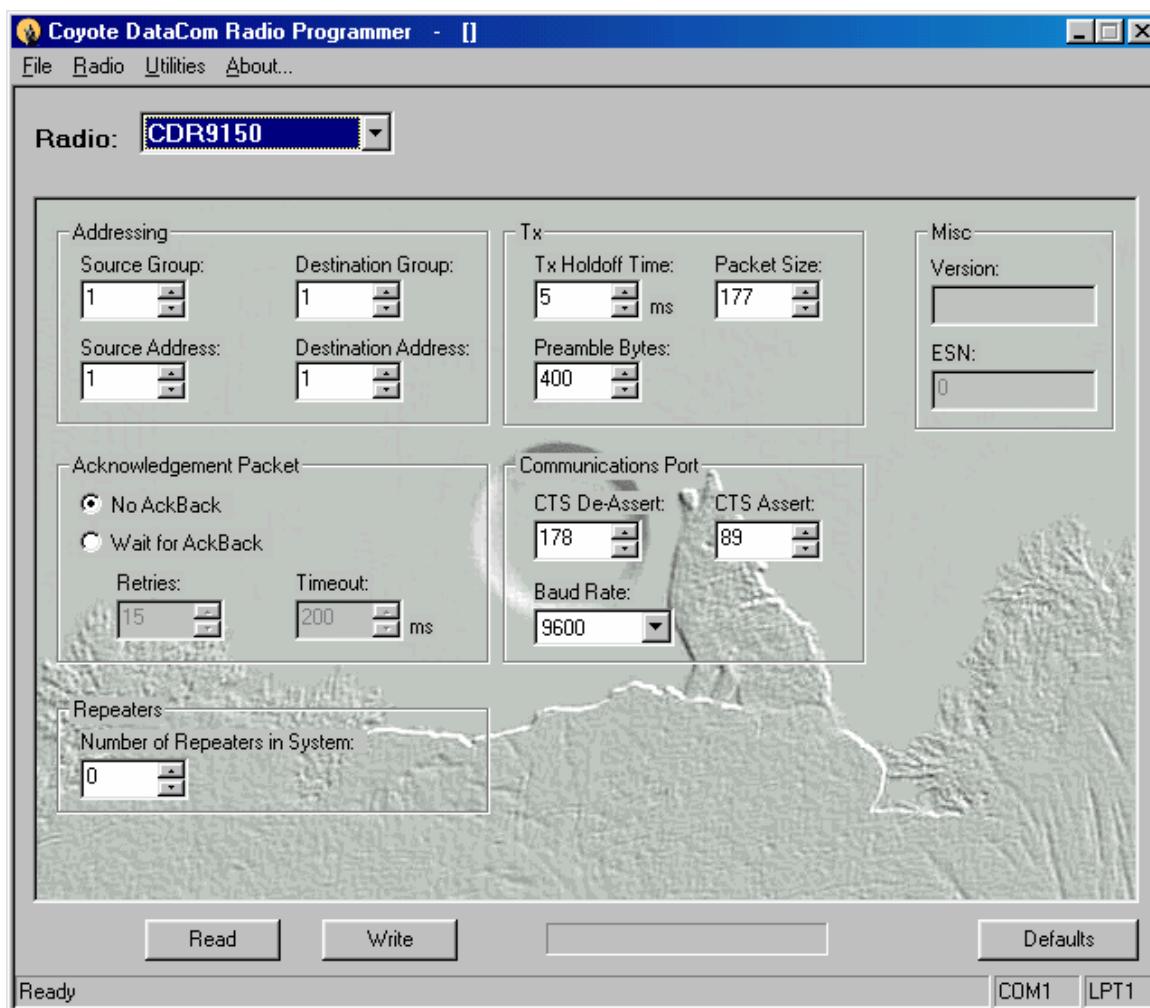
Click on the "PC Settings" tab, then select which COM port will be used to connect to the data radio. As shown below, ports COM1 thru COM4 are available. This setting will be retained the next time the configuration program is run.
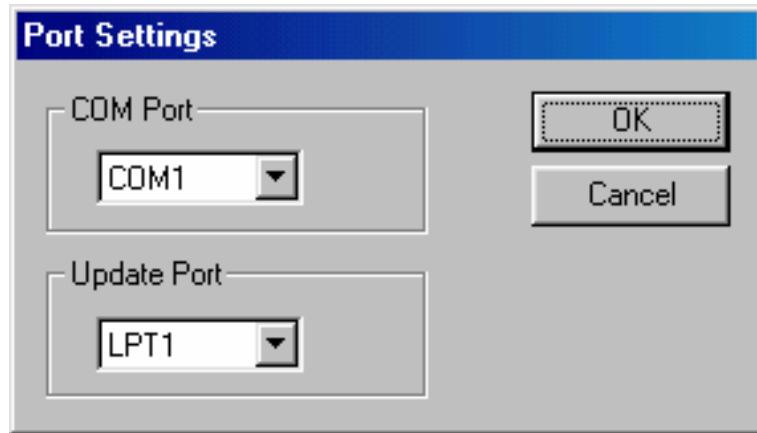

Getting Started

To configure the radio, click on the appropriate tab for the radio being configured. Then select the radio Communications Port. The default setting is for asynchronous serial mode, UART (Universal Asynchronous Receiver/Transmitter). The default baud rate is 9600 bits per second. The interface baud rate can be set to standard values between 2400 and 57600 as shown on the following page. This mode supports 8 data bits, 1 stop bit and no parity.

CDR-915 OEM DATA RADIO MODULE
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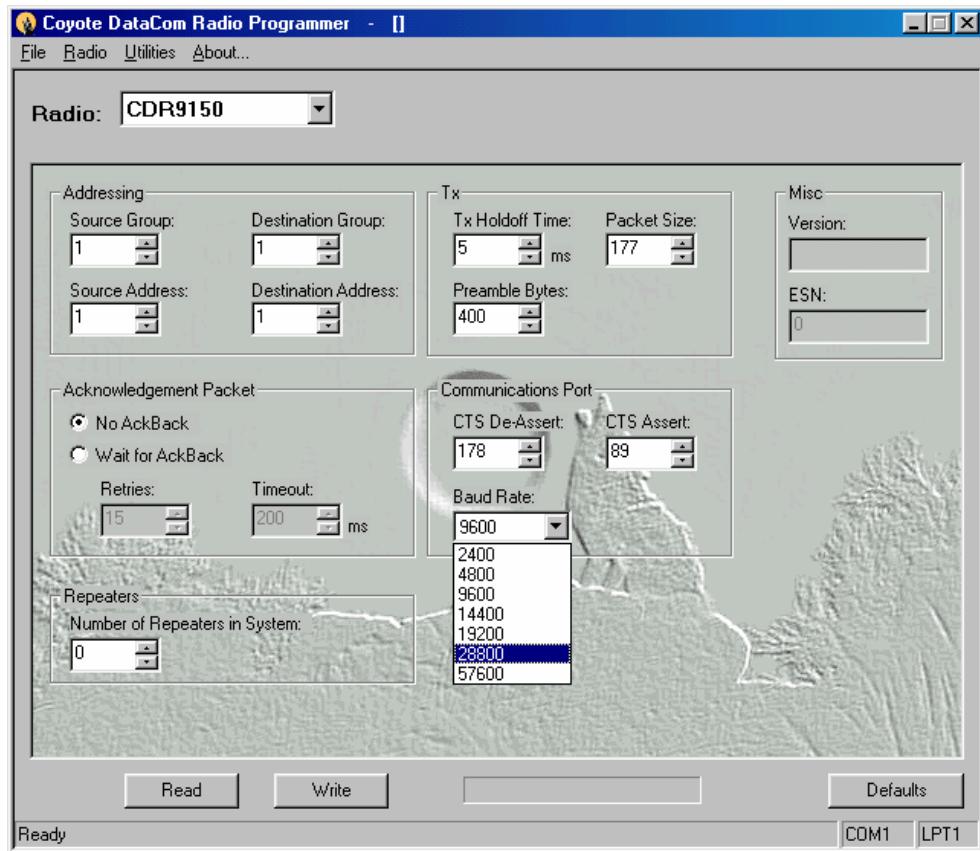
Radio Options
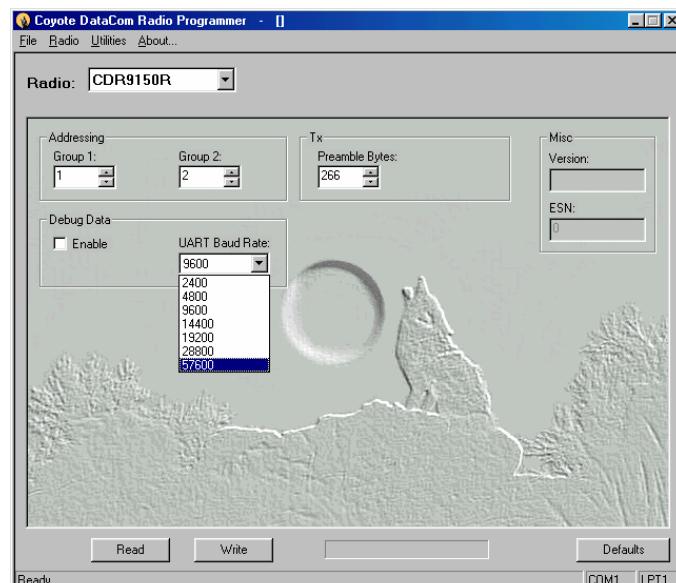
Repeater Options

Addressing

The radio has been designed to be very versatile in its addressing functions. Each radio has its own identifier consisting of a group number and address number.

The Source Group specifies which group of radios the unit being configured belongs to. The Source Address specifies the address within that group that uniquely identifies this radio. The radio will decode packets containing a Destination Group and Address matching its own. With the exception of broadcast messages, all others will be ignored.

Broadcast messages are those messages where the destination address is 0 and the group is the same as the radio receiving it, or those messages where the destination address and group are both 0. When the destination group is set to 0, all radios in all groups will decode the packet.

Likewise, the Destination Group specifies which group of radios the transmissions will go to. The Destination Address specifies the individual radio within that group that will receive the message.

TX Hold Off Time

TX Hold Off Time sets the amount of time that must elapse after the last byte to be transmitted is received by the radio before a transmit packet will be initiated. Setting this value higher will prevent numerous small packets from being sent when the transmit data is not continuous. The default setting will be adequate for most applications.

Acknowledgement (Ack-Back™)

The CDR-915 has powerful built-in path management features designed to make OEM integration quick and easy. Activating packet acknowledgement will virtually guarantee all data transmitted is received. Any packet transmitted by the CDR-915 is then acknowledged by the receiving radio. If any packet is not acknowledged, the transmitting radio will resend the data. While reducing throughput, this feature also handles missed transmissions as well as performs path management, allowing full duplex communications.

The Retries field specifies the number of attempts the radio will make in trying to resend unacknowledged packets. The Timeout field determines how long the radio will wait for the acknowledgement before resending. (See Hardware Timing for more information)

Number of Repeaters

The range of the CDR-915 may be extended by using repeaters. Repeater modules receive data packets on one group code and retransmit the packet on another group code. For example, a repeater configured with group codes 3 and 4 will translate the following packets and retransmit them as follows:

- A packet received with a destination group code of 3 will be received and retransmitted with a destination group of 4.

- A packet received with a destination group code of 4 will be received and retransmitted with a destination group of 3.

This method of group code translation guarantees that data is transferred through the repeater and not directly between radios.

When the CDR-915 is in Ack-Back™ mode and there are repeaters in the system, the amount of time needed to receive packet acknowledgements increases. By specifying the number of repeaters in the Configuration program, this delay is calculated and the radio is updated correctly. **Always set this field with the maximum number of chained repeaters in the system.**

Path Management

The CDR-915 has powerful path management tools to help ensure successful field installations. The Path Management window has two modes, Continuous and On-Sync.

The Continuous mode is not available for the CDR-915. The Spectrum Analyzer mode should be used instead.

The On-Sync mode allows the installer to look only at radio transmissions for CDR-915 radios. When packets are received, the transmission's current and maximum signal strength is displayed along with the packet's source group code and address. This allows the installer to ensure there is adequate signal strength with enough fade margin to guarantee reliable operation. Signals in the green area are considered very reliable, those in the yellow area are marginally reliable and signals in the red area are considered not reliable.

The graph will display information for as many as 16 radio addresses. As new addresses are received, they will replace the oldest ones in the graph. The last received signal is indicated by a crosshatch in the bar. Clicking on the Stop button will reset the graph information.

On-Sync Signal Monitoring
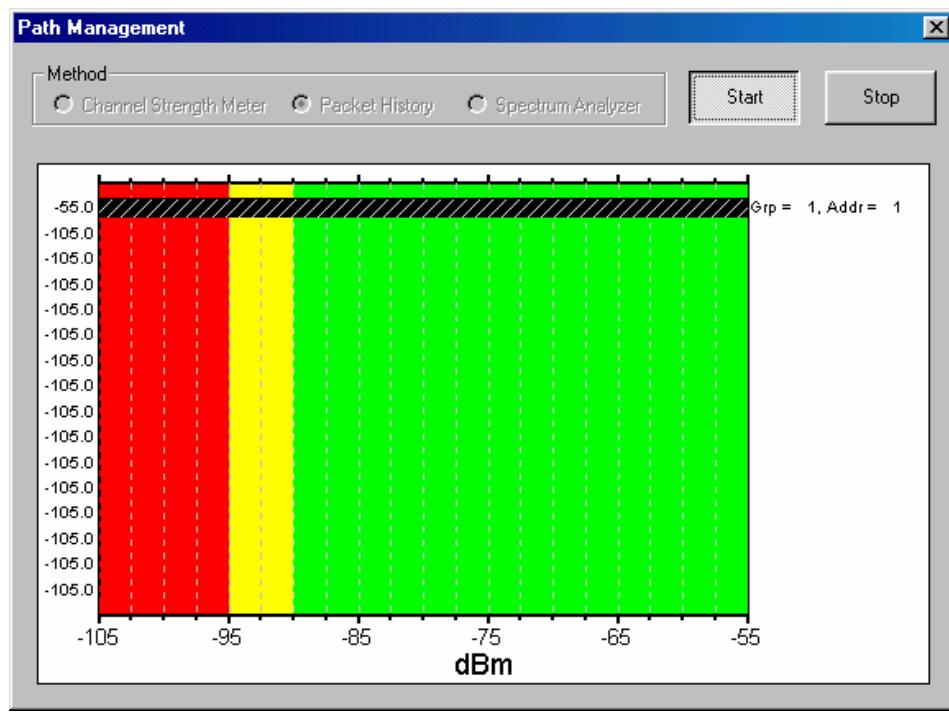
The Spectrum Analyzer mode allows the installer to look at the ambient radio energy on each channel the radio operates on. This mode is useful in determining what competing signals are present at the install site. Signals with higher amplitudes are more likely to cause interference problems.
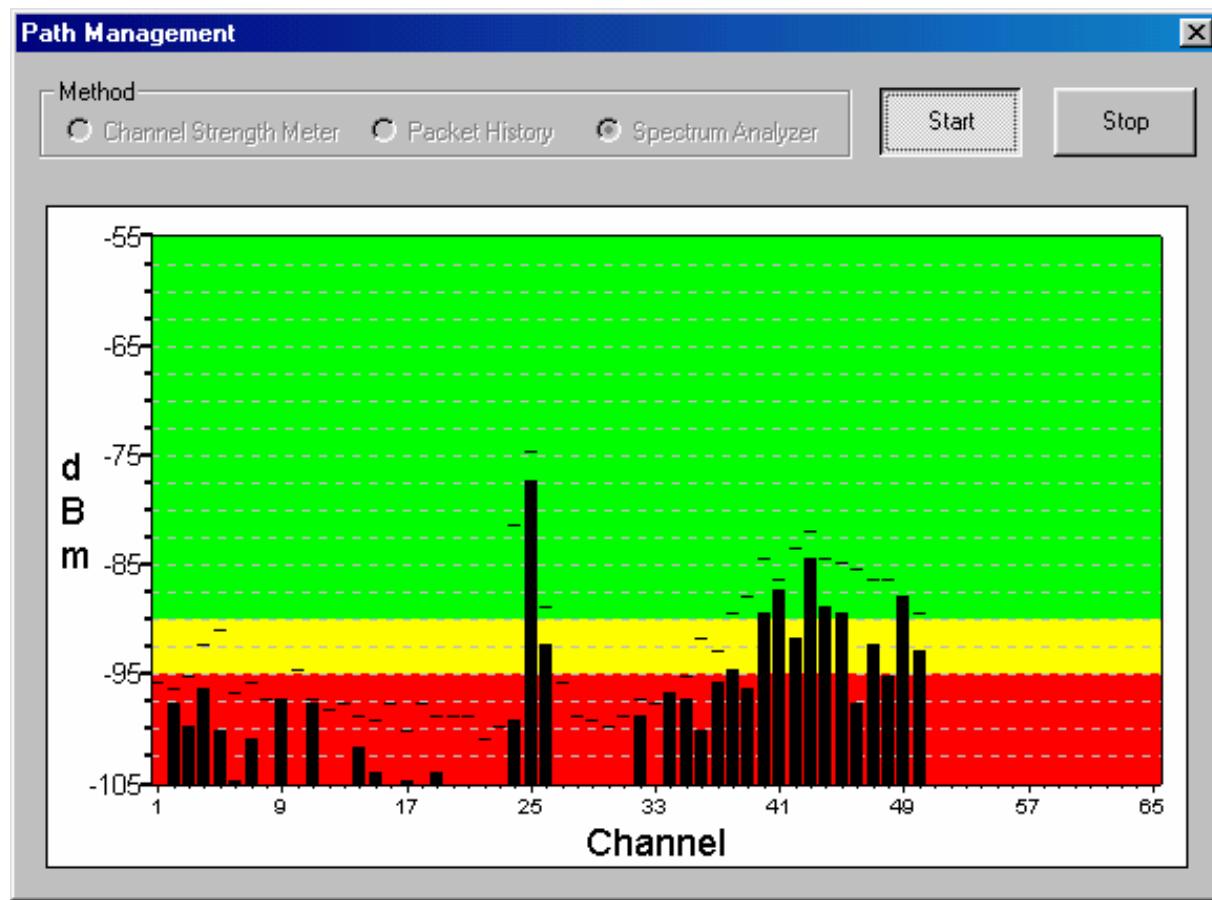
Spectrum Analyzer Mode

Spectrum Analyzer Mode Code Upgrading

The CDR-915 has been designed for easy field upgrades. Using the RS-232 Serial Adapter board, a CDR Family Programming cable, a standard Serial Configuration cable and a current version of the CDR-915 Configuration program running on the user's PC, the radio can be re-flashed with new operating code. Special customer code can also be loaded in this manner.

With the radio mounted on an RS232 Serial Adapter board, connect a program upgrade cable from the programming connector, J4, on the Adapter board to the parallel port on the PC. Connect a standard DB9 male-to-female serial cable from the Adapter board's DB9, J2, and to the serial port on the PC. Power the Adapter board using the supplied 12-volt wall module connected to the Adapter board's power jack, P8.

Using the CDR-915 Configuration program, click on the Flash tab. Select the desired software version from the Software Version drop-down box and then press the Program Flash button. The Configuration program will then read the setup information from the radio, upgrade the radio code and reload the original configuration.
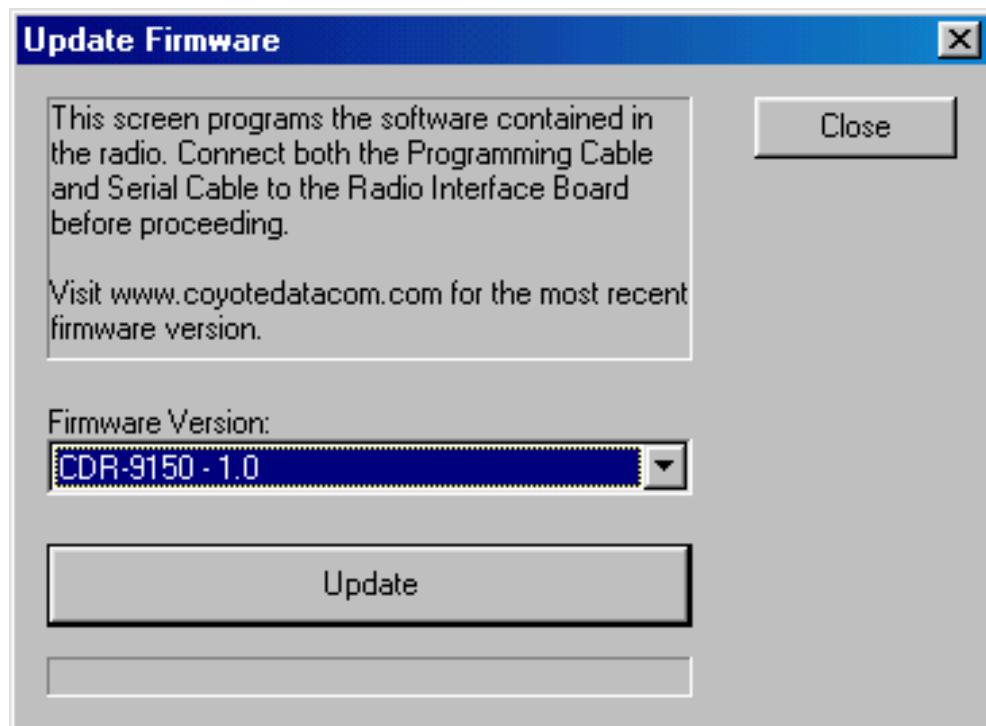
Flash Upgrade Tab

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CDR-915 Data Radio
SPECIFICATIONS

Overall

Frequency .... 902-928 MHz
Frequency Control ....PLL Synthesizer
Transport... Transparent, Point-to-Point Guaranteed
Data Interface ....Asynchronous Serial, TTL
Hopping Channels...25
Configuration .... Windows™ Application using PC Serial Port
Duty Cycle ....100% receive, 50% transmit
Data Interface Rate .... 2400,4800,9600,19.2k,56k bps (N,8,1)
Temperature .... -30 to +70 °C
Range... up to 10 miles depending on conditions
Data Encoding..Proprietary Method
Receiver Sensitivity ....-101 dBm usable
Modulation .... Direct FM (FSK)
RF Data Rate...50 kbps
Data Flow Control ....Hardware using CTS
Transmitter Output 200mW
Error Detection... 16 bit CRC

Power Requirements

Input Voltage .... 7.5 – 15 VDC
Input Current .... 70 mA Receive Mode
                                                             250 mA Transmit Mode

Regulatory

United States (FCC) ....CFR 15.247 Approved
Canada (IC) .... RSS-210 Approved

Mechanical

Size .... 1.75″ x 2.925″
Antenna Connector .... Reverse SMA

CDR-915 Data Radio
RADIO HARDWARE INTERFACE

CDR-915 Mechanical Overview
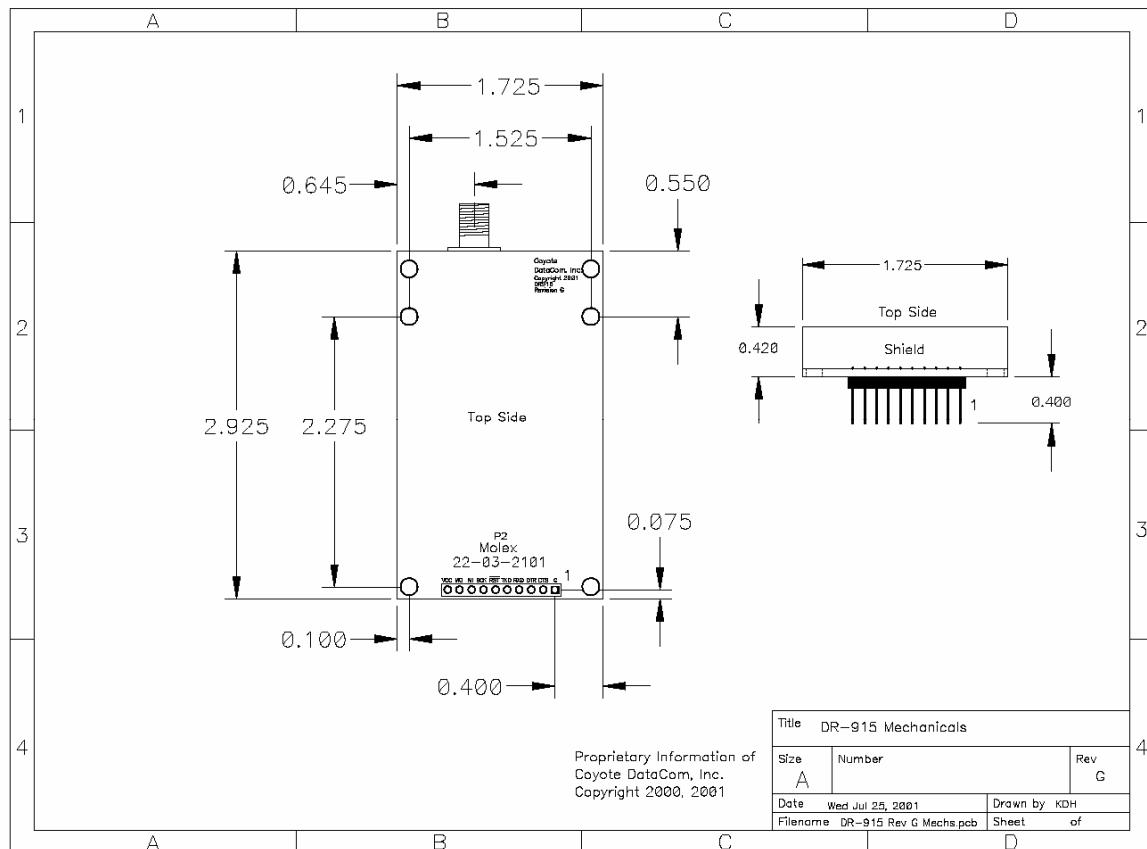
CDR-915 Data Radio
RADIO HARDWARE INTERFACE

Pin Definitions for Connector P2

PIN	FUNCTION
1	Ground
2	CTS
3	DTR
4	Receive Data
5	Transmit Data
6	Reset
7	SPI Clock
8	SPI MISO/Fail
9	SPI MOSI/Sending
10	VCC

PIN 1 – Ground

Power and signal ground for the data radio.

PIN 2 – CTS

Clear to Send. This line will be low when the radio is ready to accept data to transmit. When the radio raises this line, the user application must cease sending data to the radio or a buffer overflow may occur resulting in a loss of data.

PIN 3 – DTR

Data Terminal Ready. This line is used to place the radio into configuration mode. It should be held low for normal operation.

PIN 4 – Receive Data

This is data received by the radio and sent out to the user device. The data format is a standard asynchronous stream at the user-set baud rate with one start bit (low) followed by 8 data bits and one stop bit (high). This is a TTL-level

interface. Applications requiring RS-232 must use an appropriate interface circuit or a CDR-915 RS-232 interface board.

PIN 5 – Transmit Data

This is the data sent by the user device for the radio to transmit. The data format is a standard asynchronous stream at the user-set baud rate with one start bit (low) followed by 8 data bits and at least one stop bit (high). This is a TTL-level interface. Applications requiring RS-232 must use an appropriate interface circuit or a CDR-915 RS-232 interface board.

PIN 6 – Reset

Taking this pin low will reset the radio's micro controller. For normal operation, this pin should be left open.

PIN 7 – SPI Clock

This pin is used for updating the code in the radio.

PIN 8 – SPI MISO

This pin indicates a failure to complete an transmission while in Ack-Back™ mode. This pin is also used for updating the code in the radio.

PIN 9 – SPI MOSI

This pin indicates the radio is attempting a transmission while in Ack-Back™ mode. This pin is also used for updating the code in the radio.

PIN 10 – VCC

This is power to the radio. It should be 7.5 to 15 vdc.

CDR-915 Data Radio

APPROVED ANTENNAS

The CDR-915 is approved for use with the following antennas:

- Antenex model FG8963 (3dB) omni-directional base station antenna
- Antenex model FG8966 (6dB) omni-directional base station antenna
- Antenex model YS8963 (6dB) Yagin antenna
- Antenex model YS8966 (9dB) Yagin antenna
- Cushcraft model PC904N (6dB) Yagi antenna
- Cushcraft model PC906N (9dB) Yagi antenna
- MaxRad model MUF9000 (0dB) ¼ wave mobile antenna
- Coyote DataCom model ANT-915DEV (0dB) ¼ wave rubber antenna
- Coyote DataCom model ANT-915CW (0dB) ¼ wave shortened rubber antenna

CDR-915 Data Radio

RS-232 INTERFACE BOARD

The INT-232DR is a serial adapter board that allows the user to easily connect to the CDR-915 Data Radio using a standard DB-9 serial cable. The interface board also provides visual indication of data coming from and going to the user-connected equipment.
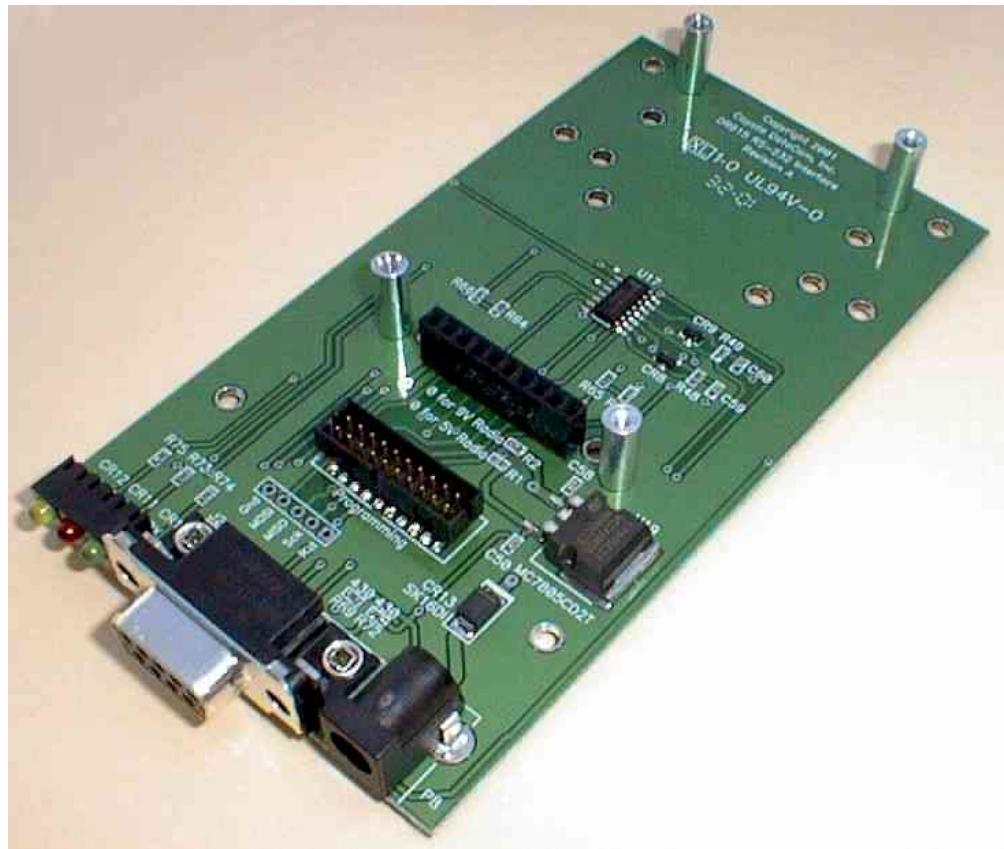
INT-232DR RS232 Interface Board

LED Indicators

Yellow indicates the radio is ready to accept data from the user-connected equipment.

Green indicates data is being sent from the radio to the user-connected equipment.

Red indicates data is being sent from the user-connected equipment to the radio.

DB-9 Pin Out (RS-232)

PIN 1 – DCD (Data Carrier Detect) is always held high by the radio.
PIN 2 – RD (Receive Data) is serial data from the radio to the user device.
PIN 3 – TD (Transmit Data) is serial data from the user device to the radio.
PIN 4 – DTR (Data Terminal Ready) indicates the user device is ready to send data to the radio for transmission. When this line is high, the radio will transmit any data across the RF network. When this line is low, the radio will process the data as commands. *If this pin is unused it should be tied to PIN 1.*
PIN 5 – GND (Ground) is the interface common.
PIN 6 – DSR (Data Set Ready) is always held high by the radio.
PIN 7 – RTS (Request To Send) is not connected on an RS-232 Interface board.
PIN 8 – CTS (Clear To Send) is used to indicate to the user device that the radio can accept more data. When this line is high, the user device is clear to send more data. When this line is low, the user device should not send data. (This line may be ignored at baud rates of 2400 and 4800 bps. The TX Packet size should be changed to 150 bytes to prevent a buffer overflow.)
PIN 9 – RI (Ring Indicator) is not connected on an RS-232 Interface board.

DB-9 Pin Out (RS-485)

PIN 1 – Unused
PIN 2 – Unused
PIN 3 – Unused
PIN 4 – Unused
PIN 5 – GND (Ground) is the interface common.
PIN 6 – Unused
PIN 7 – RS-485-
PIN 8 – Unused
PIN 9 – RS-485+

Power Connector Pin Out

The power connector should receive 9-15 VDC at 300mA. The 2.5mm x 5.5mm jack is center positive.

CDR-915 DATA RADIO
## HARDWARE TIMING

Ack-Back™ Handshaking

When configured for Ack-Back™ mode, the radio will attempt to resend packets that are not acknowledged as received by the destination radio. While this virtually guarantees that data will be correctly transmitted, there is still the possibility that the destination radio is unavailable. Because of this, the CDR-915 supplies hardware indication of the success or failure of Ack-Back™ packets. (See Radio Hardware Interface for pin definitions)

Shown below is an example of the hardware handshaking for a successful Ack-Back™ transmission. The **TX** trace identifies the actual transmission attempt and is internal to the radio. The **SNDING** trace is the handshake signal on Pin 9 of P2. This signal goes high when the transmit attempt is made and stays high until the acknowledgement packet is received from the destination radio.
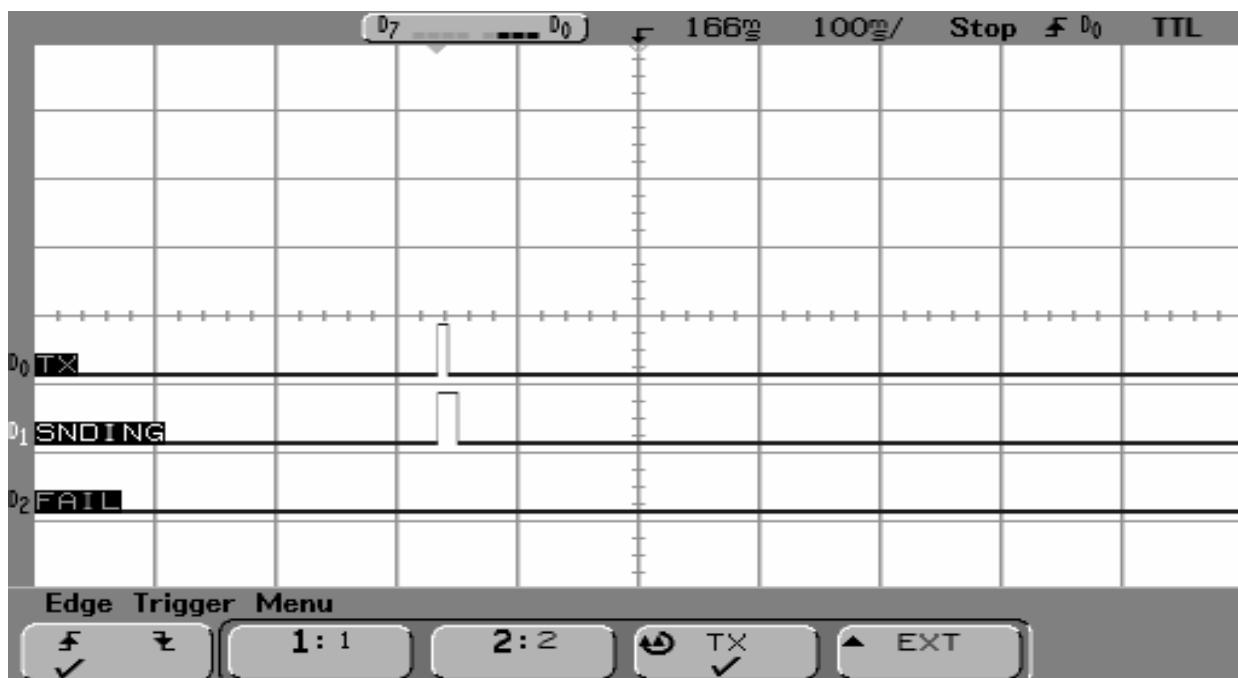
Successful Ack-Back Transmission

If and acknowledgement is not received within the **Ack-Back™ Timeout** time, the radio will resend the packet up to the **Ack-Back™ Retries** setting. If an acknowledgment is received during one of the retries, the **SNDING** signal will return low, indicating a successful transmission. If there is no acknowledgement after all retry attempts, the **SNDING** line will return low and the **FAIL** line will go high to indicate a transmission failure

Failed Ack-Back Transmission
After 3 Retries
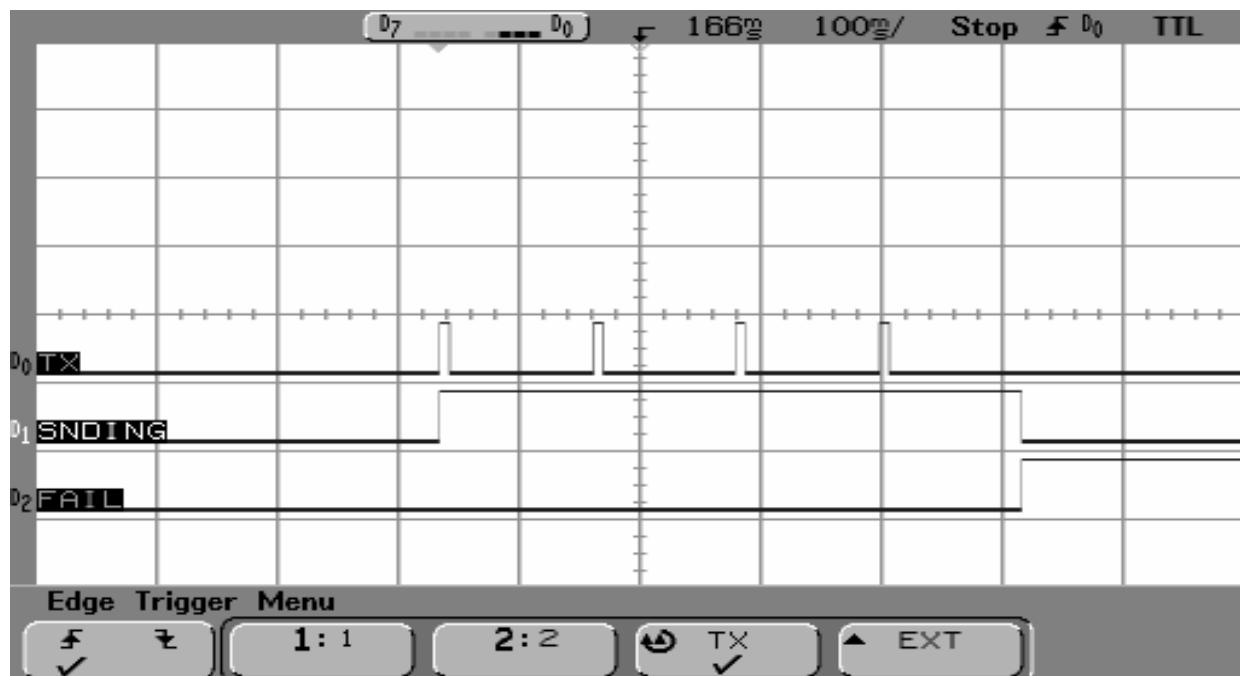
CDR-915 DATA RADIO
IN-SYSTEM CONFIGURATION

The CDR-915 may be reconfigured while in a host system. This allows the user's system to change the source or destination address and group codes on-the-fly, adding great versatility to the Ack-Back™ delivery mode.

General Structure

The general structure of the protocol for programming the CDR915 radio is as follows:

[0xAA] [command] [checksum] [0x55]

where *command consists of byte #1, byte #2, byte #3, …, byte #n as defined below, and*

where *the checksum is an 8-bit checksum (a simple unsigned 8-bit addition of bytes) of data bytes 1 thru n, 0x55, and*

where *the checksum does not include the beginning 0xAA, itself, or the ending 0x55.*

Numbers preceded by "0x" are hexadecimal. All others are decimal.

The DTR pin must be raised prior to sending any commands to the radio. Once a complete command has been sent to the radio, the DTR pin should be immediately lowered. If a read command of some sort was issued, the device should be ready to receive the information immediately. If a Write Command was issued, the device must allow 250 milliseconds for the radio to reboot itself with the new values before any other commands can be issued.

As bytes are sent to the radio, each byte will be immediately echoed back to the sender for confirmation that the radio received the byte.

When any data is being read from the radio, the device should simply read in the data without echoing the bytes back to the radio.

EEPROM values are loaded on power-up. Values written to RAM will be used until the radio loses power.

Command Structure

The format of the data bytes for sending a command to the radios is as follows:

Read command:

- 0x01 (1 byte)
- memory select (1 byte) (0 = read from EEPROM, 1 = read from RAM)
- beginning address (high byte) (1 byte)
- beginning address (low byte) (1 byte)
- number of bytes to be read (1 byte)

Write Command:

- 0x02 (1 byte)
- memory select (1 byte) (0 = write to EEPROM, 1 = write to RAM)
- beginning address (high byte) (1 byte)
- beginning address (low byte) (1 byte)
- number of bytes to be written (1 byte)
- byte #1 to be written
- byte #2 to be written
- byte #3 to be written
- byte #n to be written

Path Management:

-0x03 (1 byte)
-mode (1 byte) (0 = off, 1 = every 250ms & on-sync, 2 = on-sync.)
This command returns a series of packets 6 bytes long. The packet structure is as follows:

-0xAA (1 byte)
-counter (high byte) (1 byte)
-counter (low byte) (1 byte)
-source group (1 byte)
-source address (1 byte)
-0x55 (1 byte)

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Read Model Command:

- 0x04 (1 byte)
This command returns an ASCII string 15 bytes long.

Read Software Version Command:

- 0x05 (1 byte)
This command returns an ASCII string 15 bytes long.

Read Serial Number Command:

- 0x06 (1 byte)
This command returns 4 bytes with the least significant byte first.

Addresses of Settings

CAUTION! *The radio software performs no validation of settings. Great care should be taken when programming any of these settings.*

CDR915 Address Map:

0x0001 = Not used

0x0002 = Tx Hold off (Valid range = 5 - 255. Default = 5.)

0x0003 = Preamble Bytes (**high byte**)

0x0004 = Preamble Bytes (**low byte**)   (Valid range for the two byte value = 16 - 1000. Default = 16. A value of less than 16 will cause improper operation.)

0x0005 = Destination Group (Valid range = 0 - 255 where 0 is broadcast group.)

0x0006 = Destination Address (Valid range = 0 - 255 where 0 is broadcast address.)

0x0007 = Source Group (Valid range = 1 - 255. A value of 0 must not be used.)

0x0008 = Source Address (Valid range = 1 - 255. A value of 0 must not be used.)

0x0009 = Packet Length (Valid range = 1 - 177. Default = 177.)

0x000A = CTS Deassert Limit (Valid range = 1 - 178. Default = 178. This value should be greater than the CTS Assert Limit.)

0x000B = CTS Assert Limit (Valid range = 1 - 177. Default = 89. This value should be less than the CTS Deassert Limit.)

0x000C = Baud Rate (*See below for proper settings.)

0x000D = Ack-Back™ Enable (Valid range = 1 is enabled, 0 is disabled.)

0x000E = Ack-Back™ Retries (Valid Range = 0 - 255.)

0x000F = Ack-Back™ Timeout (Valid Range = 50 - 255.)

0x0010 = Communications Port (Valid range = 0 is SPI port, 1 is UART.)

0x0011 = Number of Repeaters in System (Valid range = 0 - 255.)

CDR915 Repeater Address Map:

0x0001 = Not used

0x0002 = Preamble Bytes (high byte) (Valid range = 266 - 1000. Default = 266. A value of less than 266 will cause improper operation.)

0x0003 = Preamble Bytes (low byte)

0x0004 = Group 1 (Valid range = 0 – 255.)

0x0005 = Group 2 (Valid range = 0 – 255.)

0x0006 = Baud Rate (*See below for proper settings.)

0x0007 = Debug Enable (Valid range = 1 is enabled, 0 is disabled.)

*Baud Rate settings for the CDR915 and Repeater are as follows:

2400 baud = 215
4800 baud = 107
9600 baud = 53 (default)
14400 baud = 35
19200 baud = 26
28800 baud = 17
38400 baud = 12 (not recommended for use)
57600 baud = 8

CDR-915 DATA RADIO
REGULATORY

FCC Compliance Warning

Changes or modifications to the CDR-915 not expressly approved by Coyote DataCom, Inc. could void the user's authority to operate this product.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.